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FOREWORD

This test was conducted early in 1964 in an underground Minuteman launch control facility at the Boeing Pacific Test Center, Vandenberg Air Force Base. The test was conducted jointly by the Boeing Company and the USAF School of Aerospace Medicine under the direction of the Ballistic Systems Division of the United States Air Force. Participation by the School of Aerospace Medicine involved a broad range of psychologic and psychiatric approaches to operational problems of aerospace crew efficiency. This report was prepared by—

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Like all studies conducted in the field on operational systems, the support of many personnel was required. We wish to acknowledge particularly the assistance of Major Robert DiVall at BSD and Captain Jacob T. Chachkes, and other members of the 392d Medical Group at Vandenberg Air Force Base.

ABSTRACT

Two civilian subjects successfully completed 30 days of unbroken confinement in an underground Minuteman launch control center with an open-loop air supply. Logistic supplies were self-contained. During the test, they ate, slept, and performed duties similar to those that would be required of an operational crew in a postnuclear attack environment. Their performance score was high (99.75% level) with no critical errors. Morale throughout the test was excellent, with minimum of interpersonal friction. No physiologic or psychologic changes were observed which would compromise the integrity of the weapon system. Alterations in sleep patterns obtained were consistent with predictions based on work levels.

This technical documentary report has been reviewed and is approved.

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HUMAN FACTORS ASPECTS OF A 30-DAY EXTENDED SURVIVABILITY TEST OF THE MINUTEMAN MISSILE

1. INTRODUCTION

The United States Air Force has entered into an era of highly reliable advanced intercontinental ballistic missile (ICBM) systems. The men who operate these systems may be required to participate in an extended survival mode that will closely resemble the isolation and confinement aspects of space cabin studies that have been conducted by the School of Aerospace Medicine (1-4). Whereas the space cabin studies were conducted in the laboratory, the Minuteman Test Program at Vandenberg Air Force Base gave researchers one of the first opportunities to monitor subjects confined in an actual ICBM underground launch control center under simulated but realistic postnuclear attack conditions.

The Minuteman Weapon System is a hardened and dispersed complex of solid propellant ICBM facilities under the command of a series of manned underground launch control centers. The centers are designed to enable the effective launch of programed missiles after nuclear attack. The system also incorporates features that allow for extended survival of the operational crewmen, who must be able to perform required operations many days after the start of confinement. The following 30-day study was carried out to demonstrate the capability of personnel to satisfactorily survive for a portion of the survival period for which the system was designed.

2. METHOD

Four Boeing Company employees (2 life scientists and 2 engineers), selected from a group of volunteers, were sent to the USAF School of Aerospace Medicine (SAM) after initial medical screening at the Boeing Company. At SAM the candidates underwent a comprehensive medical and psychologic-psychiatric evaluation. This evaluation was described in detail by Lamb (5). In essence, it is an intensive medical examination designed for personnel being considered for special, high-priority programs.

Minor modifications were made in the psychologic evaluation. Tests administered were the Wechsler Adult Intelligence Test, the Rorschach, the Thematic Apperception Test, the Draw-a-Person Test, the Bender Visual-Motor Gestalt Test, the Edwards Personal Preference Schedule, the California Personality Inventory, and the Gordon Personal Profile. Test findings were integrated with the psychiatric evaluation to select the 2-man crew from the 4 candidates and to provide baseline data against which to evaluate psychiatric problems which might arise during the test, and to evaluate change in personality functioning, occurring as a result of the test.

In addition to these procedures, there was a brief interview with each of the 2 subjects just before the 30-day test commenced, and some psychologic tests were administered when the 30-day study was completed. These post-test measures included parts of the Wechsler Adult Intelligence Scale, the Thematic Apperception Test, the Edwards Personal Preference Schedule, the Minnesota Multiphasic Personality Inventory, and the Draw-a-Person Test.

All 4 candidates were found medically qualified for the test. The candidates, in addition to their high level of general fitness,

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understood the function and operation of the Minuteman Weapon System. All the candidates were college graduates. On the basis of the psychiatric findings, the candidates were paired into 2 teams—I and II. Team I was given first priority and participated in the test. The men on this team had not met before they were selected as test candidates. One was a life scientist and the other was an engineer. Prior to the test, Team II stood by as the alternate.

The facility used was the Minuteman Wing III Launch Control Facility at Vandenberg AFB, consisting of an underground launch control center (LCC) which housed the crew and their display—control equipment and support items; an underground launch control equipment building (LCEB) which contained the standby diesel generator (for electrical power) and the environmental control system; an above-ground support building which served as the monitoring center; and the interconnecting tunnels and an elevator which connected the various facilities (see fig. 1).

The Launch Control Center also contained a standard Air Force bed, an electric oven-refrigerator-freezer, two custom-built operator chairs, a water-flush toilet, and a lavatory basin with hot and cold running water. Although the water supply was limited to the capacity of the facility storage tank, sufficient water was available for drinking, food preparation, personal hygiene, and periodic toilet flushing. Other support and personal kit items are listed in appendix A. Safety equipment was provided both in the Launch Control Center and immediately outside the capsule door. Emergency medical support was available from the VAFB Hospital at a moment's notice. Instrumentation for measuring the environmental parameters of the Launch Control Center was provided in the monitoring room of the Support Building. Gas samples were drawn from the Launch Control Center via an interconnecting nylon tubing and were analyzed. Because of the high reactiveness of ozone and oxides of nitrogen, the measuring instrumentation was installed directly in the capsule with remote readout. Parameters measured were as follows: oxygen, measured every four hours; carbon dioxide, measured every two hours; carbon monoxide, measured every half hour; combustible explosive gases, measured every half hour; and ozone and oxides of nitrogen, measured continuously. Grab samples were taken every few days and analyzed. Measurement procedures and instrumentation are described more fully in reports from the Boeing Company (6, 7). Basically, however, they were those used in industrial hygiene programs. No significant amounts of acid gases, reducing gases, or halogenated hydrocarbons were found before the test.

Simulated weapon system displays and controls for operation by the crewmen were combined into two special consoles and installed adjacent to the respective operator chairs in the Launch Control Center. This constituted the "duty simulation," which was nearly identical to the actual operational equipment. Umbilical cables provided continuity between these units and a master simulator program and monitor console located in the monitoring room of the Support Building. The simulator system was designed so that the aboveground monitoring team could continuously monitor the status of each of the remote consoles and program and initiate status changes on the remote consoles. The subjects' simulator duties included: message encoding and decoding; monitoring status changes (indicator lights); selecting switch positions; actuating various types of switches; recognizing and resetting audible and visual alarms; and making decisions and cooperating in actions to be taken.

Other duties consisted of routine inspection of capsule electronics, inspection and adjustment of facility mechanical equipment, and keeping personal diaries and other test records, including a daily report on sleep.

The food supply consisted of 90 food packet, in-flight individual meals with varied menus and a 15-day research food kit, which was specially prepared for the test. The research food kit was nutritionally balanced and contained a large proportion of freeze-dried meats

FIGURE 1

Artist's conception of the Minuteman launch facility.

and vegetables.[1] The schedule for using the food supply was: days 1 to 10, in-flight meals; days 11 to 20, research food kit meals; days 21 to 30, combination of remaining in-flight and research food kit items, ad libitum. Typical menus for both are listed in appendix B. Utensils for preparing meals were included.

The week before the test started, the subjects received training in the operation of the duty simulator and the other simulated or real weapon system functions and duties. Simulator training was carried out until error-free performance was obtained. The subjects were also trained in the preparation of meals, safety, first aid, and emergency procedures, and in the use of self-contained breathing apparatus and photographic equipment. The monitoring team also received training in first aid and in the use of the 2-man resuscitator located outside the capsule.

A series of isotonic and isometric exercises was used by the test subjects as a means of maintaining a "net level" of physical fitness throughout the confinement period. These exercises were developed at Washington State University and have been recognized by the Congress of Physical Medicine as an effective means of maintaining motor fitness with a minimum of time, space, and equipment. The isotonic exercise program consisted of four selected motor fitness exercises which were selected to maintain strength, speed, agility, balance, endurance, and power. The exercises used were: (1) situps (modified), (2) pushups, (3) squat thrusts, and (4) forward bends (modified). The isometric exercise program consisted of seven selected static muscle exercises. These were: (1) scapular adduction and hold, (2) hand opposition and hold, (3) knee extension and hold, (4) brachial flexion and hold, (5) scapular elevation and hold, (6) hyperextension of vertebral column and hold, and (7) static abdominal flexion and hold. The subjects performed one set of isotonic and two sets of isometric exercises per day.

Photographic coverage of test subjects in the Launch Control Center during the test was provided, utilizing 4 motion picture cameras (3 fixed mount and remote controlled, 1 portable) and 1 Polaroid Land camera. The subjects were informed prior to any fixed camera filming. Live microphones were placed in the capsule to provide continuous monitoring in the capsule for safety purposes and to allow tape recording of the subjects' responses to test commands and any other significant verbal behavior. The subjects did not know that they were being monitored; however, some of their remarks during the test indicated that they were suspicious of the microphone system.

At the beginning of the test, the Launch Control Facility was placed in a mode that simulated a postnuclear attack situation. The subjects were instructed to think of their confinement in this aspect.

The following levels were representative of the general capsule working environment. The sound-pressure level was approximately 80 db, reference 0.0002 dyne/cm.^{2} with a speech interference level of 58 db. Illumination ranged from 25 to 100 ft.-c. on working surfaces. Temperature ranged from 69° to 77° F. with a daily average of 73° F. An approximately normal sea level atmosphere was provided. The test configuration featured an "open-loop" system with fresh air being circulated through the air entrainment system of the Launch Control Equipment Building. A portion of the LCEB atmosphere constituted make-up air for the LCC environmental control system. The test was conducted subject to rigid personnel safety test restrictions. The list of these restrictions may be found in appendix C.

The work-rest schedule was set up as follows: Each subject followed a predetermined schedule consisting of 8 hours on-duty (subject seated in chair, other subject sleeping); 2 hours off-duty (subject seated in chair), 2 hours

[1] Regarding the adequacy of in-flight meals for extended survival, the staff of the U. S. Army Quartermaster Corps Natick Laboratory pointed out that the in-flight meals were not nutritionally balanced, being very low in ascorbic acid (5 mg. per meals average versus 25 mg. per meal required) and low in vitamin A for most of the 10 menus.

Time (hours)

	0	8	10	12	14	16
Subject A	Duty	REST	DUTY	REST	DUTY	Sleep and personal hygiene
Subject B	Sleep and personal hygiene	DUTY	REST	DUTY	REST	Duty

FIGURE 2

Work-rest schedule for a complete 24-hour cycle of the 30-day test.

on-duty, 2 hours off-duty, 2 hours on-duty; and 8 hours for sleep, personal hygiene, and custodial duties, phased so that there was a crewman on duty at all times. A complete cycle is shown in figure 2.

Changes in sleep patterns received systematic attention. Each morning, the subjects filled out a sleep report (fig. 3). Although the form contains spaces for reporting dreams, the emphasis was on sleep per se. Subjects began reporting daily about two months before the test, to provide baseline information, and continued reporting throughout the 30-day period of confinement in the capsule.

3. RESULTS AND DISCUSSION

General findings

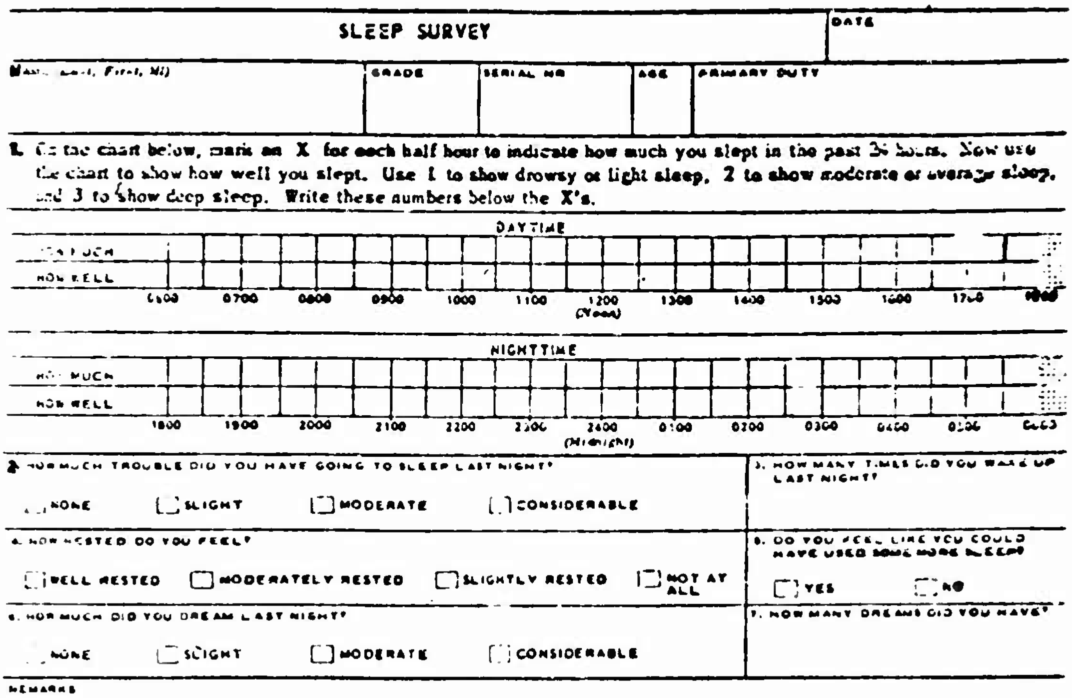
The test ran successfully for the scheduled 30-day period.

The concentrations of oxygen and carbon dioxide did not deviate from ambient surface levels. The concentrations of hazardous gases at no time exceeded the thresholds, safety limits, or exposure indexes specified. No significant amounts of acid gases, reducing gases, or halogenated hydrocarbons were found.

The performance of the subjects was satisfactory. During the test, 141 simulated operational events were programed in a random fashion. The subjects responded correctly to 6,904 out of 6,921 possible operations for a performance score of 99.75%. The 17 errors (subject A-7, subject B-12) were randomly distributed in time throughout the test and none was critical. This indicated that there was no significant performance degradation.

The test subjects reported that the in-flight, individual meals, although nutritious, were eaten without enthusiasm for the first 10 days. The subjects reported that although there were different in-flight menus, they all "tasted the same." The subjects reported that the research food, from the 11th to the 20th day, was much more palatable and desirable. They also reported that their general morale improved as a result of the dietary change. In-flight meals were supplemented with research food items (days 21 to 30) such as milk, spreads, citrus juices, bread, and frequent freeze-dried entrees. This supplemented diet was also deemed superior to in-flight meals alone.

No somatic symptomatology requiring intervention occurred during the test period. Subject A reported in his diary the occurrence of four incidences of headache (days 4, 9, 11, and 20), occasional dryness of oronasal passages (apparently caused by the low relative capsule humidity), and a back pain in the thoracic region (day 26). On day 27, he reported that he felt at "low ebb," which was followed by rising spirits the next day. Subject B reported two headaches (days 10 and 18), a sore throat (day 2), back pain (days 5



SLEEP SURVEY

DATE

NAME (Last, First, MI) | GRADE | SERIAL NO | AGE | PRIMARY DUTY

1. On the chart below, mark an X for each half hour to indicate how much you slept in the past 24 hours. Now use the chart to show how well you slept. Use 1 to show drowsy or light sleep, 2 to show moderate or average sleep, and 3 to show deep sleep. Write these numbers below the X's.

DAYTIME

HOW MUCH

HOW WELL

0600 0700 0800 0900 1000 1100 1200 (Noon) 1300 1400 1500 1600 1700 1800

NIGHTTIME

HOW MUCH

HOW WELL

1800 1900 2000 2100 2200 2300 2400 (Midnight) 0100 0200 0300 0400 0500 0600

2. HOW MUCH TROUBLE DID YOU HAVE GOING TO SLEEP LAST NIGHT?

NONE SLIGHT MODERATE CONSIDERABLE

3. HOW MANY TIMES DID YOU WAKE UP LAST NIGHT?

4. HOW RESTED DO YOU FEEL?

WELL RESTED MODERATELY RESTED SLIGHTLY RESTED NOT AT ALL

5. DO YOU FEEL LIKE YOU COULD HAVE USED SOME MORE SLEEP?

YES NO

6. HOW MUCH DID YOU DREAM LAST NIGHT?

NONE SLIGHT MODERATE CONSIDERABLE

7. HOW MANY DREAMS DID YOU HAVE?

REMARKS

FIGURE 3

Self-reporting sleep survey form used to obtain data on sleep behavior.

to 7) and an upset stomach (day 24). He reported feeling depressed on day 20. This subject also reported that the last 2 hours of the 8-hour duty shift "alone" (subject A sleeping) were the hardest to complete. The period of sleep following this shift, however, served to restore his morale.

Review of the subjects' double Master's pretest and posttest electrocardiograms revealed no changes that occurred as a result of confinement. Clinical pretest and posttest biomedical data are given in appendix D.

A review of this data reveals a decrease in hematocrit and hemoglobin values for both subjects. Without plasma volume studies, this finding is difficult to interpret, but it is probably due to a decrease in red cell mass, since other inactivity experiments would not lead one to expect an increase in plasma volume immediately after confinement (8). The change is presumably related in some way to restricted activity. The blood pressure and pulse data and the absence of clinical symptoms during immediate posttest activity suggest that no cardiovascular deconditioning occurred

of a degree which would interfere with operational effectiveness.

Psychiatric findings

Morale was generally excellent throughout the test. During the first few days, while the subjects accustomed themselves to the duty schedules and developed a routine, both noticed some degree of fatigue and dysphoria. In addition, they had various minor somatic complaints such as headache, sore throat, muscle aches, and upset stomach. These were considered to be due to a combination of fatigue, dry air, and tension. As one subject wrote in his diary:

> The first three days were the breaking-in period. Getting used to the various sounds, the same old surroundings, the daily routine of cooking, eating, sleeping (not too much), working, and in general, just getting used to the environment.

Within a few days they became more adept with routine chores, were able to organize their activities better, and slept more soundly during their off-duty time. This resulted in an improved state of well-being which continued generally throughout the remainder of the test. At no time did either subject entertain the idea that he might not be able to complete the allotted time.

Each subject considered his partner to be an agreeable person who carried his share of the load and was easy to get along with. On the 10th day, one subject wrote in his diary:

> ______________ seems to be very well adjusted to our life here. He sings very nicely and it is a pleasure to hear. I believe he is a well-adjusted person and adaptable. In addition he is not a shirker; he jumps in and gets things done. So far, I have not found any irritating characteristics.

On the 4th day his partner wrote:

> ______________ and I have no personal problems with each other. He is very cooperative and quite willing to do his share of the duties. I am trying to do the same.

There were no significant interpersonal difficulties. One subject wrote in his diary after about two weeks:

> People had told me prior to my coming down here that after 30 days, ______________ and I would be sick and tired of each other. Thirty days haven't passed yet, but I don't think we will. We aren't really together that much. We seem to be living in the same places but at different times.

On only one occasion was there evidence of disagreement. This concerned a difference of opinion about a technical procedure which occurred on the 20th day. The engineering subject resented not having the final say on technical problems, and commented in his diary:

> . . . no responsibility or authority was given to either of us prior to the test. If I were to do it again, this would have to be different.

This type of disagreement over procedures was one of the common sources of interpersonal irritation in the Space Cabin Simulator Studies (9), and we agree with the subject quoted that clearly designated authority in an operational setting would minimize this source of difficulty.

Both subjects were frequently preoccupied with the passage of time and attempted to combat boredom by structuring activities and setting intermediate goals for themselves. Both accomplished a great deal of planned study during the test, but they also found that lighter reading, solitaire, or other recreational activities were helpful. On one occasion the subjects temporarily relieved their boredom by actuating all the simulator lamps simultaneously, admittedly for the purpose of "shaking up" the monitoring team. One subject cataloged in his diary all of the ambient noises:

> MG (2 or more frequencies), air conditioning, air movement (many high and low frequencies), refrigerator-freezer (motor and Freon flow), diesel engine (through blast door), alarm clock, 24-hour watch, mast ozone analyzer meter, heater fans, sump pump, shock isolator air movement, buzzer alarm in simulator, voice communications.

During the last few days, both subjects were aware of an increased tension. As one subject wrote:

> I had figured that after this past weekend was over, I would relax and these last few days would be a snap. This is not the case. I suppose it is because as we get closer to the end, my anticipation gets the best of me. I find I am getting tired of our constant daily routine of eating, studying, reading, exercising, shaving, and the rest. I know that my mental guard has dropped. It is harder for me to suppress the thoughts of normal living, of being with my family, performing recreational activities, just being able to get away from these surroundings.

Both subjects noted periods of depressed spirits, usually associated with fatigue. They learned to tolerate them, realizing that the spell would be temporary and would be relieved by a period of sleep. For example, one subject wrote on day 19:

> Did the dishes and went to bed. I was very tired and I felt somewhat depressed. I just wanted to get to bed. I knew that sleep would relieve that depressed feeling—sleep seems to be man's wonder drug. I don't know if there was any one thing in particular which made me feel depressed. I probably allowed myself too much thought about the outside which I shouldn't have done.

On day 27, the other subject wrote:

> This seems to be a low ebb in my monthly (?) cycle. I have done poorly on solving my correspondence course questions and I am generally discouraged. I asked_______________if he had any escapist literature and he does . . . that should help . . . I do not believe that being here in LCC is completely responsible for my low ebb feelings. This happens at times—it is nothing of consequence—I recognize it and chart my course accordingly. I think it must be somewhat common for most people. I think I have just learned to cope with it or—just don't fight it.

Thus, although both subjects at times had feelings of irritation and discouragement, they dealt with them constructively and did not allow them to influence behavior or in any way interfere with their duty performance.

For the most part, the subjects maintained a formal, impersonal relationship with each other. This was in part due to the minimal interaction imposed by their work-sleep schedule. It is also consistent with our prediction based on the pretest psychologic-psychiatric evaluations and on our selection of team members. Pretest findings showed all 4 candidates to be of superior intelligence. They revealed mixed motivations for participation in the test, but the motivational components were generally appropriate and much like the components we have seen in candidates for other special programs. Since the test included both human factors and engineering aspects, it appeared desirable to have each skill represented on the team. With 2 men in the pool having each skill, four pairings were possible. On the basis of psychologic and psychiatric assessment, it appeared that 2 of the group had strong affiliation and interpersonal needs and would have reacted to each other in a mutually satisfying manner. The other 2 were relatively independent and autonomous in interpersonal relationships and would be expected to function as individuals despite being a team. Either of these pairings would have seemed functionally appropriate.

We asked the subjects to indicate preference for teammates. From a brief acquaintance, the subjects in their self-selection would have paired an individual high in affiliation needs, with an autonomous, impersonal subject. Perhaps each sensed in the other something which he felt lacking in his own personality. Figure 4 shows the possible pairings. It may be that had there been more time for the subjects to have become acquainted, their self-selection might have been different. It appeared, however, that had we followed the choices made by the subjects, disillusionment would have resulted during the course of prolonged association.

It must be acknowledged that little is known at present about optimal matching of crew members. The state-of-the-art in this area is discussed more fully in a literature review by the two senior authors (10). The test itself, however, provided some guide lines which could be used in matching up teams. Since the work-rest schedule was such that most of the time

TABLE I

Average amount of sleep per day for each subject

Test period	Duration of sleep					
	Subject A			Subject B		
	Mean	S.D.	"Daytime" sleeping (naps)*	Mean	S.D.	"Daytime" sleeping (naps)*
Baseline period (December 1963)	8.3	1.4	Rare	7.2	0.8	None
Immediate pretest period	7.4	1.3	Rare	5.3	0.9	Frequent
First 10 test days	6.7	0.6	Frequent	6.0	0.8	Frequent
Second 10 test days	7.3	0.7	Frequent	6.0	1.0	Rare
Third 10 test days	6.9	1.0	Frequent	5.4	0.7	Rare

*Naps were included in computing mean durations of sleep.

Sleep findings

Sleep data obtained from the self-reporting forms (see figure 3) were analyzed to evaluate changes in gross sleep behavior during the test. On the basis of theoretic considerations discussed in detail in a separate paper (12), it was predicted that the subjects would sleep less in the capsule than in their normal environment. Confinement in the limited environs of the capsule carries with it a concomitant reduction in activity and the total amount of work performed, particularly (in this case) the work of locomotion. In our formulation, the reduction in total work performed should be accompanied by a reduction in the total amount of sleep.

A period of 30 days before the test was selected to provide the normal sleep pattern for each subject. Mean duration of sleep during the two weeks immediately prior to the test was also calculated. This period cannot be used as a baseline value, however, because the subjects were on a standby status, due to a delay in the test schedule, and were not on a normal routine. Three 10-day intervals were used, while the subjects were in the capsule, to calculate mean sleep duration early, in the middle, and late in the test.

The findings are presented in table I. Both subjects showed a reduction in the mean duration of sleep in the capsule. Both also showed a decrease during the standby period just before the test. One (subject B) showed a considerable drop, like that while in the capsule. Graphic analysis indicated that he adopted a pattern appropriate to his upcoming work-rest schedule during the standby period, possibly in preparation for the test. Subject A, whose average sleep exceeded the time allotted in the capsule, adopted a regular routine of daytime naps, although his total sleep time was still less than in a normal setting. Although findings on only 2 subjects are not an adequate test of such a broad hypothesis, the changes clearly support the prediction.

4. CONCLUSIONS

This study is an example of an infrequent joint undertaking by biomedical and engineering groups to evaluate an operational weapons system under field conditions. A fundamental,

jointly shared position underlying the test was that man is a vital part of the system and that to test the system, man must participate and perform as a system component in the manner expected of him.

The findings reported here, limited to biomedical aspects, demonstrate that the test was successful. The life-support system maintained the crewmen adequately and the crewmen performed their functions at a high level of efficiency for 30 days. Physiologic and psychobiologic changes (i.e., decreases in hematocrit and hemoglobin and alterations in sleep patterns) were as expected, but they did not compromise the integrity of the system. On the basis of extensive studies in simulated space flight, it had been predicted that no psychiatric problems would occur. This prediction was confirmed. At the conclusion of the test, the subjects declared that they probably could have continued for another 30-day period if it had been necessary. It is reasonable to presume that they could have successfully completed a period that long or even longer.

By-products of considerable value were obtained, such as information on food and logistics. Not reported here, but of extreme utility, was the identification of hardware deficiencies which probably could not have been revealed except in a field test such as this. In our experience, these hardware deficiencies are frequently the most valuable aspects of these tests. In general, the test constitutes an additional demonstration of the durability and adaptability of man to unusual requirements.

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APPENDIX A

LOGISTIC ITEMS

I. Extended Survival Kit — Thirty-Day Test

Lantern, head, battery powered	2
Apparatus, breathing, self-contained	2
Water, canned—emergency supply	
Food packet, in-flight, individual—15-day supply	
Kit, food, research—15-day supply	
Pan, baking, 8 in. x 8 in.	1
Tin, muffin, 6-cup	1
Opener, can	2
Kit, cooking, camp	2
Cup, hot drink	50
Knife, table	2
Fork	2
Spoon, tea	2
Spoon, table	2
Cup, measuring	1
Spoon, measuring	1 set
Mitts, hot-pad type, long	2
Spoon, mixing	1
Pitcher, plastic, 1 qt.	1
Spatula, small	1
Towel, cotton, bath	8
Boots, fleece lined	2 pair
Cap, wool, stocking	2
Coveralls, cotton, white	4
Gloves, cotton	2 pair (ea.)
Jacket, wool, flight type	2
Shirts, cotton	4
Stockings, cotton	4 pair
Sweater, wool	2
Underwear, cotton, long, thermal tops and bottoms	4 pair (ea.)
Mattress	1
Pillow, foam rubber	2
Pillowcase, cotton	4
Bag, sleeping, Dacron, 4 lb.	2
Liner, sleeping bag	4
Washcloth, cotton	8
Calendar	1
Pencils	1½ doz.
Sharpener, pencil	1
Pens	4
Tape, Scotch, large roll	1
Tape, masking,	1 roll
Clock, alarm, spring wound	1
Hanger, coat	8
Hammer, claw	1
Battery, lantern, head, spare	3

Bulb, lantern, head, spare	2
Knife, scout	2
Pliers, slipjoint	1
Pliers, grip	1
Polyethylene, sheet, 6 ft. x 6 ft.	1
Rope, sash cord,	25 ft.
Screwdriver — 4 in. and 12 in. (slotted head)	1
Screwdriver — 4 in. and 6 in. (Phillips)	1
Shovel, escape	1
Wire, copper, insulated, No. 12	20 ft.
Wrenches — adjustable, 8 in. and 12 in.	1
Wrenches — box	1 set
Wrenches — open end	1 set
Wrenches — escape hatch, 1⅙ in. x $1^{13}/_{16}$ in., 24 in. handle	2

II. First Aid Kit[1]

Septisol squeeze bottle, 8 oz.	1 bot.
Zephiran Chloride spray, 1 oz.	1 bot.
Band-aid plastic strip, 100	1 box
Band-aid, extra large	12
Gauze sponges, 4 in. x 4 in., 2/pkt.	6 pkt.
Adhesive tape, 1 in.	1 roll
Cotton buds	1 pkg.
Kienzette	12
Baywipes	1 box
Aspirin, 5 gr.	200
Dermoplast spray, 8 oz.	1 can
Safety pins	12
Splinter forceps	1

Test unique items

Clinical thermometer, oral with case	2
Desenex Aerosol, 6 oz.	1 can
Neo-propisol Ophthalmic Solution, 15 cc.	1 bot.
Gelusil tablets	204
Phillips Milk of Magnesia, 1 pt. (10 oz.)	1 bot.
Parepectolin Suspension, 8 oz.	1 bot.
Marezine, 50 mg.	100

III. Emergency Treatment Chest

Provisional contents

First aid manual	1
Yucca padded splint set	2 sets
Wire splint	2
Bandage, triangular	2
Bandage, Ace, 3 in.	4

[1] This kit was developed for everyday use.

Bandage, scissors, 5½ in.	1
Band-aid plastic strips, 100	1 box
[illegible]esive tape ½ in.	1 roll
Adhesive tape 1 in.	1 roll
Adhesive tape 2 in.	1 roll
Gauze, 2 in. roller	2 rolls
Gauze sponges, 4 in. x 4 in., 2/pkg.	12 pkt.
Gauze sponges, 2 in. x 2 in., 100/pkg.	1 pkg.
Gauze dressing packs, BAC, sterile	2 packs
Surgipads, small, sterile	2
Tourniquet (rubber, 2½ in. x 9 ft.)	1
Klenzettes	50
Safety pins	12
Cotton buds	1 pkg.
Tongue blades, sterile	10
Splinter forceps	1
Septasol squeeze bottle, 8 oz.	[illegible]
Zephiran Chloride spray, 1 oz.	[illegible]
Neosporin Aerosol, 90 gm.	[illegible]
Desenex Aerosol, 6 oz.	[illegible]

IV. Housekeeping Kit

Apron, plastic	1
Ashtray, plastic	2
Broom	1
Brush, toilet	1
Can, garbage, plastic, 28 gal.	1
Cigarette, butt container	1
Cleaner, scouring, powdered	1 can
Cleanser, toilet, powdered	1 can
Deodorizers, Air-Wick type.	5
Detergent, liquid	12 oz.
Detergent, powdered	1½ lb.
Dish pan, plastic	1
Dust cloth, cheese cloth	1 pkg.
Fire extinguisher, CO_2, 15 lb.	1
Kit, first aid	1
Flashlight, 2 cell, magnetic mount	1
Batteries, flashlight, spare	6
Bulbs, flashlight, spare	2
Gloves, rubber	2 pair
Mirror, shaving, 10 in. diameter	1
Mop, cellulose, self-contained wringer	1
Pads, scouring, large box	1
Pail, 10 qt.	1
Paper, toilet	5 rolls
Plunger, toilet bowl	1
Soap, toilet, castile	6
Sponge, plastic	1
Towel, dish, cotton	4

Towels, paper, disposable	3
Basket, waste	2
Broom, whisk	4

V. Personal Kits

(Personal items taken into the test by the subjects)

Subject A	Subject B
Antihistamine tablets	Chap stick
Chap stick	Coricidin tablets
Dental floss	Dermassage
Deodorant	Deodorant
Ear plugs	Ear plugs
Foot powder	Foot powder
Glasses and case	Glasses and case (contact)
Hair brush	Hair brush
Hair cream	Hair cream
Hand lotion	Kleenex
Kleenex	Micrin mouth wash
Mentholatum	Pepto Bismol
Nasal spray	Razor and blades
Razor and blades	Shaving cream
Shaving cream	Shaving lotion
Shaving lotion	Styptic pencil
Shaving talc	Toothbrush
Soap	Toothpaste
Styptic pencil	Vicks inhaler
Toothbrush	Vitamin pills
Toothpaste	Gloves, leather
Vitamin A and D ointment	Handkerchiefs
Vitamins	Gloves
Handkerchiefs	Sleep shade
Slipper socks	Wool socks
Sleep shade	Glasses (extra)
Thongs (slippers)	Shampoo
Cuticle scissors	Bible
Fingernail brush	Books — technical — 8
Needles and thread	Books — reading — 6
Scissors	Candy — 5 rolls
Shampoo	Chess set
Books (Army correspondence)	Nail clippers
(Technical — several)	Playing cards
(Reading -- 6)	Pocketknife
Pencils	
Pocketknife	
Sharpening stone	

APPENDIX B

TEST RESTRICTIONS

The test was to be terminated if any of the following conditions existed. The conditions were as follows:

1. *Oxygen.* Minimum concentration of 17% by volume at sea level if not correctable within five minutes.

2. *Carbon dioxide.* Maximum concentration of 2% by volume at sea level if not correctable within thirty minutes.

3. *Carbon monoxide.* Maximum exposure index (hours of exposure times parts per million) equal to 700 over any 8-hour period or a maximum instrument reading of 100 p.p.m., whichever occurs first.

4. *Oxides of nitrogen.* Maximum exposure index equal to 100 over any 8-hour period or a maximum instrument reading of 20 p.p.m., whichever occurs first.

5. *Other toxic gases.* Maximum concentration for 8-hour periods not to exceed values listed in ACGIH (American Conference of Government Industrial Hygienists) Threshold Limit Values for 1962, subject to interpretation by the medical staff and environmental parameter monitors.

6. *Combustible gases.* Maximum concentration equal to one-fourth the lower combustible limit at any instant.

7. *Medical emergency.* Any condition so evaluated by the SAM-VAFB 392d Medical Staff as a critical medical emergency.

8. *Critical crew support equipment failure.* Any condition involving the facilities or equipment which is deemed hazardous by the test operator.

9. *Lack of communication response from the capsule for more than one minute.*

10. *Environmental control system out of tolerance.*

11. *Permanent power failure.*

APPENDIX C

TYPICAL MENU

Food packet, in-flight, individual

Breakfast

Ham and eggs	Cream, dry
Pears	Sugar
Pecan cake roll	Salt
Instant coffee, tea	Gum

Lunch

Boned chicken	Cream, dry
Peaches	Sugar
Pound cake	Salt
Instant coffee, tea	Gum

Dinner

Beef steak	Cream, dry
Fruit cocktail	Sugar
Chocolate nut roll	Salt
Instant coffee, tea	Gum

Research food kit

Breakfast	Portion size		Caloric value
Omelet	3 oz.		212
Toast	1 slice		55
Jam	1 tbs.		50
Butter	1 pat		50
Pineapple juice	6 oz.		91
Coffee, tea, or cocoa	1 cup		104
Milk	1 cup		165
		Total	727

Lunch			
Beef macaroni	¾ cup		295
Diced carrots	3 oz.		14
Coffee, tea, or cocoa	1 cup		104
Snack			
Cheese and crackers	4 crackers		94
	1 slice		113
Orange juice	6 oz.		81
		Total	701

Dinner			
Pork chops (freeze dried)	2 lean		300
Whipped potato	4 oz.		120
Gravy, mushroom	3 tbs.		123
Green beans	3 oz.		9
Cookies, plain	2		218
Coffee, tea, or cocoa	1 cup		104
Milk	1 cup		165
		Total	1,039

APPENDIX D

BIOMEDICAL DATA

	Subject	Pretest	Posttest
I. Hematology			
A. Erythrocytes	A	4.48 million	4.21 million
N = 5.0 million	B	5.08 million	4.50 million
B. Hemoglobin	A	15.6 gm.	14.0 gm.
N = 16.0 gm. ± 2 gm.	B	15.6 gm.	14.0 gm.
C. Hematocrit	A	46%	39%
N = 42 to 46%	B	48%	40%
D. Leukocytes	A	5,352	5,500
N = 5 to 10,000/mm.	B	8,050	9,005
1. Neutrophils	A	48%	58%
N = 58 to 75%	B	57%	66%
2. Lymphocytes	A	52%	35%
N = 20 to 25%	B	41%	28%
3. Monocytes	A	0%	6%
N = 3 to 8%	B	0%	3%
4. Eosinophils	A	0%	1%
N = 2 to 5%	B	2%	1%
5. Basophils	A	0%	0%
	B	0%	0%
II. Urinalysis			
A. Specific gravity	A	1.028	1.020
	B	1.029	1.028
B. Albumin	A	Negative	Negative
	B	Negative	Negative
C. Sugar	A	Negative	Negative
	B	Negative	Negative
D. Abnormalities	A	None	None
	B	0-1 RBC	0-1 WBC 2-3 RBC
E. Acetone	A	Negative	Negative
	B	Negative	Negative
F. Bile	A	Negative	Negative
	B	Negative	Negative
III. Blood pressure			
A. Sitting	A	140/80	122/76
	B	148/90	148/99
B. Recumbent	A	130/60	134/80
	B	135/78	144/92
C. Standing	A	—	114/78
	B	—	128/86

IV. **Pulse rate**

A. Sitting	A	82	76
	B	80	90
B. After exercise	A	—	112
	B	—	108
C. Two minutes after exercise	A	—	84
	B	—	82
D. Recumbent	A	—	72
	B	—	78
E. After standing three minutes	A	—	80
	B	—	104

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	USAF School of Aerospace Medicine Aerospace Medical Division (AFSC) Brooks Air Force Base, Texas

13 ABSTRACT

Two civilian subjects successfully completed 30 days of unbroken confinement in an underground Minuteman launch control center with an open-loop air supply. Logistic supplies were self-contained. During the test, they ate, slept, and performed duties similar to those that would be required of an operational crew in a postnuclear attack environment. Their performance score was high (99.75% level) with no critical errors. Morale throughout the test was excellent, with minimum of interpersonal friction. No physiologic or psychologic changes were observed which would compromise the integrity of the weapon system. Alterations in sleep patterns obtained were consistent with predictions based on work levels.

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14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Survivability test Minuteman missile Postnuclear attack environment Launch control center						

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